The genus *Granulina* (Gastropoda, Marginellidae) from the Atlantic Iberian Pliocene with description of a new species from Portugal

El género *Granulina* (Gastropoda, Marginellidae) en el Plioceno Atlántico Ibérico y descripción de una especie nueva para Portugal

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ABSTRACT

The marginellid *Granulina choffati* n.sp. is described from Pliocene, uppermost Zanclean to lower Piacenzian, shallow-water sandy beds cropping out in central-west Portugal. This is the first record of *Granulina* from the Atlantic European Pliocene. *G. choffati* n.sp. is markedly similar to *G. elliptica* La Perna, 2000, known from the Pliocene of Sicily, and both species share close similarities to the Recent West African species *G. nofronii* Smriglio, Gubbioli and Mariottini, 2001. The two Pliocene species are regarded as thermophilic elements of southern affinity. The Pliocene distribution of *Granulina* in the East Atlantic ranged at least up to 40°N along the Iberian coasts and it is hypothesized that this limit shifted southward because of the Plio-Pleistocene cooling pulses.

RESUMEN

Se describe una nueva especie de Marginellidae, *Granulina choffati* n.sp., procedente de afloramientos arenosos someros del Plioceno (Zancliense superior-Piacenziense) en el centro-oeste de Portugal. Esta es la primera cita del género *Granulina* para el Plioceno Atlántico Europeo. *G. choffatti* n.sp. es muy similar a *G. elliptica* La Perna, 2000, conocida en el Plioceno de Sicilia, y ambas especies muestran marcadas semejanzas a la especie actual del oeste de Africa, *G.nofronii* Smriglio, Gubbioli y Mariottini, 2001. Las dos especies pliocénicas se consideran elementos termófilos con afinidad meridional. La distribución de *Granulina* en el Plioceno del Este Atlántico llegaba hasta almenos 40° N en la costa ibérica y se presume que este límite se haya trasladado hacia el sur a causa de crisis de enfriamiento plio-pleistocénico.

KEY WORDS: Gastropoda, *Granulina*, new species, paleobiogeography, palaeoclimatology, Pliocene, Portugal.
PALABRAS CLAVE: Gastropoda, *Granulina*, especie nueva, paleobiogeografía, paleoclimatología, Plioceno, Portugal.

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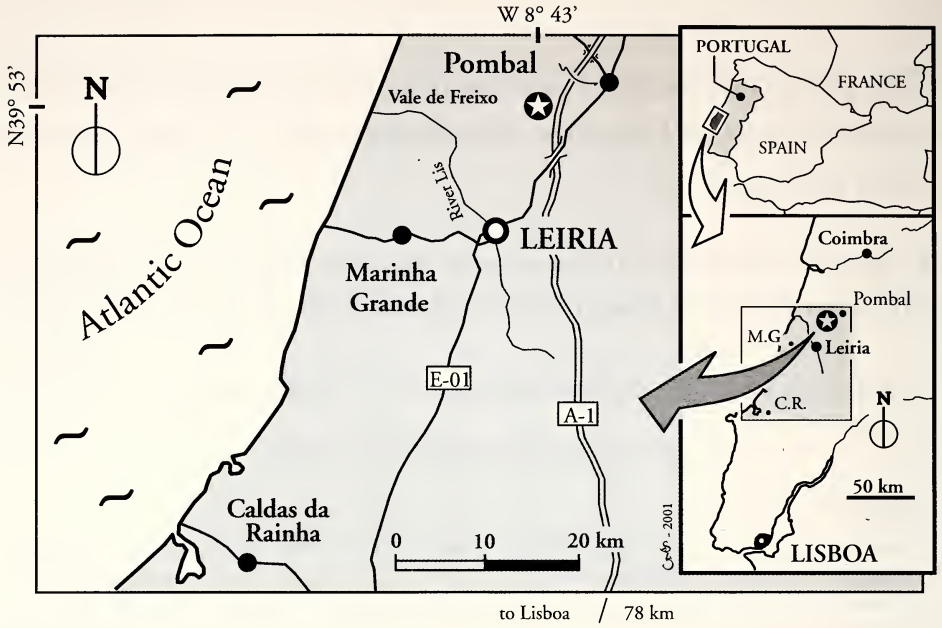


Figure 1. Location of the Vale de Freixo Pliocene outcrop in central-west Portugal.
Figura 1. Localización del yacimiento de Vale de Freixo en en centro-oeste de Portugal.

INTRODUCTION

Several recent works devoted to the marginellid genus *Granulina* Jousseame, 1888 have provided a fairly good knowledge of the composition of this genus in the Mediterranean and the adjacent Atlantic (Ibero-Moroccan Gulf south to Gulf of Guinea), and also in the Mediterranean Pliocene and Pleistocene (La Perna, Landau and Marquet, 2002, with references).

Granulina is a "southern" genus, not present in the North European waters. The Iberian coasts are the northernmost area of distribution of this genus in the East Atlantic, but little is known about its occurrence in this area. Nobre (1936) reported *G. clandestina* (Brocchi, 1814) from Portugal with no precise indication of locality, but this record was based on a misidentification, as *G. clandestina* is an extinct Pliocene species whose name was widely and uncritically used until the revision made by Gofas (1992). A list of modern European and Northwest African marginellids (Muñiz Solis, 1987) and a recent popular book on Portuguese molluscs (Macedo, Macedo and Borges, 1999) reported several species of *Granulina*, including "*G. clandestina*". None of the other species reported, *G. guancha* (d'Orbigny, 1839), *G. minusculina* (Locard, 1897) and *G. parvulina* (Locard, 1897) (= *G. occulta* Monterosato, 1869) is proved to occur north of the Ibero-Moroccan Gulf. Gofas (1992) stated that no species of this genus has ever been found in the Biscay Bay. Although the occurrence of *Granulina* in the Ibero-Moroccan Gulf is documented (Gofas, 1992), no species was found in the Sagres and Olhão areas (southern Portugal, Ibero-Moroccan-Gulf), in spite of extensive samplings carried on by the Muséum National d'Histoire Naturelle (Paris) in 1988 (Gofas, pers. comm.). Therefore, the northern limit of *Granulina* in the Eastern Atlantic must be within the Ibero-Moroccan Gulf excluding the southern Portugal, at least for the shelf species (Fig. 10).

No representative of *Granulina* had been so far reported from the Atlantic European Pliocene, but there are a few records from the Upper Oligocene and Lower Miocene of the Aquitaine basin and from the Upper Oligocene of the North Sea basin (Lozouet, 1997 and pers. comm., 2002). Recent studies on a rich molluscan fauna from Pliocene beds cropping out at Vale de Freixo, in central-west Portugal (Fig. 1), allowed the discovery of several specimens of the genus, most of them belonging to an undescribed species. Nevertheless, this new species is not the only one of the genus occurring at Vale de Freixo, a single shell of another one was found, but it is too badly preserved to be unequivocally determined. It is however similar to *G. detruncata*, recently described from the Pliocene of Malaga (southern Spain) by La Perna *et al.* (2002).

Like the previous study on the Pliocene species from the southern Iberian Peninsula (La Perna *et al.*, 2002), the present work focuses on the history of *Granulina* in the Mediterranean and adjacent Atlantic through the Plio-Quaternary.

SYSTEMATICS

Class Gastropoda Cuvier, 1797
Order Neogastropoda Thiele, 1929
Family Marginellidae Fleming, 1828
Genus *Granulina* Jousseame, 1888

Granulina choffati n.sp. (Figs. 2-6)

Type material: Holotype and 3 paratypes, National Natural History Museum of the Lisbon University (MNHN/UL.II.413-416), 9 paratypes in B. Landau coll., 1 paratype in R. La Perna coll.
Examined material: Only the type material.
Type locality: Vale de Freixo, Pombal region in central-west Portugal (Fig. 1), Pliocene, uppermost Zanclean to lower Piacenzian fine sandy beds.
Etymology: After Léon-Paul Choffat (born in 1849, in Porrentruy; died in 1919, in Lisbon), classical Portuguese geologist and palaeontologist of Swiss origin who discovered and studied the first Pliocene outcrops and molluscan faunas from Portugal.

Description: Shell minute, with immersed spire, elliptic-elongate in shape, maximum diameter at mid-length of shell, lenght/diameter *ca* 1.5. Posterior end slightly truncated to rounded, covered by a thin more or less developed callus. Siphonal notch faintly distinct. Lip moderately thickened, forming a regular arch, broader at mid length. Lip denticulations moderately fine, well defined, somewhat roundish. Four columellar plications, the uppermost two slightly smaller, obscurely excavated inside aperture by a shallow sulcus. Thin ill-defined inner parietal callus ridge running from posterior end to columellar plications. Outer parietal callus not distinct. Aperture narrow. Surface smooth but crossed by fairly well distinct growth striae. Holotype: lenght 2.1 mm, diameter 1.4 mm. Paratypes: lenght 1.8 to 2.2 mm.

Distribution: So far, only known from the type locality. The material comes from a Pliocene mostly sandy sequence, containing a particularly diverse and well preserved fauna. Recent studies on this fauna (Gili, Silva and Martinell, 1995; Silva, 1996; Nolf and Silva, 1997; Silva, Landau and Martinell, 2000; Silva, 2001) indicate a marine shallow-water (infralittoral) environment with relatively high water temperatures. The age of the Vale de Freixo fauna was referred to uppermost Zanclean to lower Piacenzian (*Discoaster tamalis*, CN12a, biozone of Okada and Bukry, 1980) by Cachão (1990; emended by Silva, 2001,

by means of Strontium $^{87}Sr/^{86}Sr$ dating) and to the Mediterranean Pliocene Molluscan Unit 1 of RAFFI AND MONEGATTI (1993) and MONEGATTI AND RAFFI (2001) by SILVA (2001). For general stratigrafical setting, Vale de Freixo graphic columnar section, and additional references see SILVA *ET AL.* (2000).

Remarks: The most similar fossil species is *Granulina elliptica* La Perna, 2000 (Figs. 7-9) described from the Lower-Middle Pliocene of Sicily (LA PERNA, 2000) (Fig. 10). In both species the shell has a markedly elliptic shape, with maximum diameter at mid length. Such a shape is rather unusual for the genus, since the maximum diameter often is within the posterior (adapical) third, giving an ovate (rather than elliptic) shell outline. *G. choffati* n.sp. is even more regularly elliptic than *G. elliptica*, in which the maximum diameter tends to be slightly above the mid point. A parietal callus ridge almost inside the aperture is present in the shell of both species, as well as an inner parietal sulcus producing an "excavation" of columellar plications (LA PERNA *ET AL.*, 2002). However, the callus ridge, sulcus and excavated plications are much more developed in *G. elliptica* than in *G. choffati* n.sp., and these are the main distinctive features between these species. Lip denticulations are somewhat roundish in both species, particularly in *G. elliptica*, in which they are also notably coarser. The outer parietal callus (LA PERNA, 1999; LA PERNA *ET AL.*, 2002) is not distinct in both species. In *G. elliptica* the shell is more swollen, and the outer lip lacks the central broadening which is more or less developed in *G. choffati* n.sp. It is also worth noting the shallow-water (infralittoral) distribution of both species.

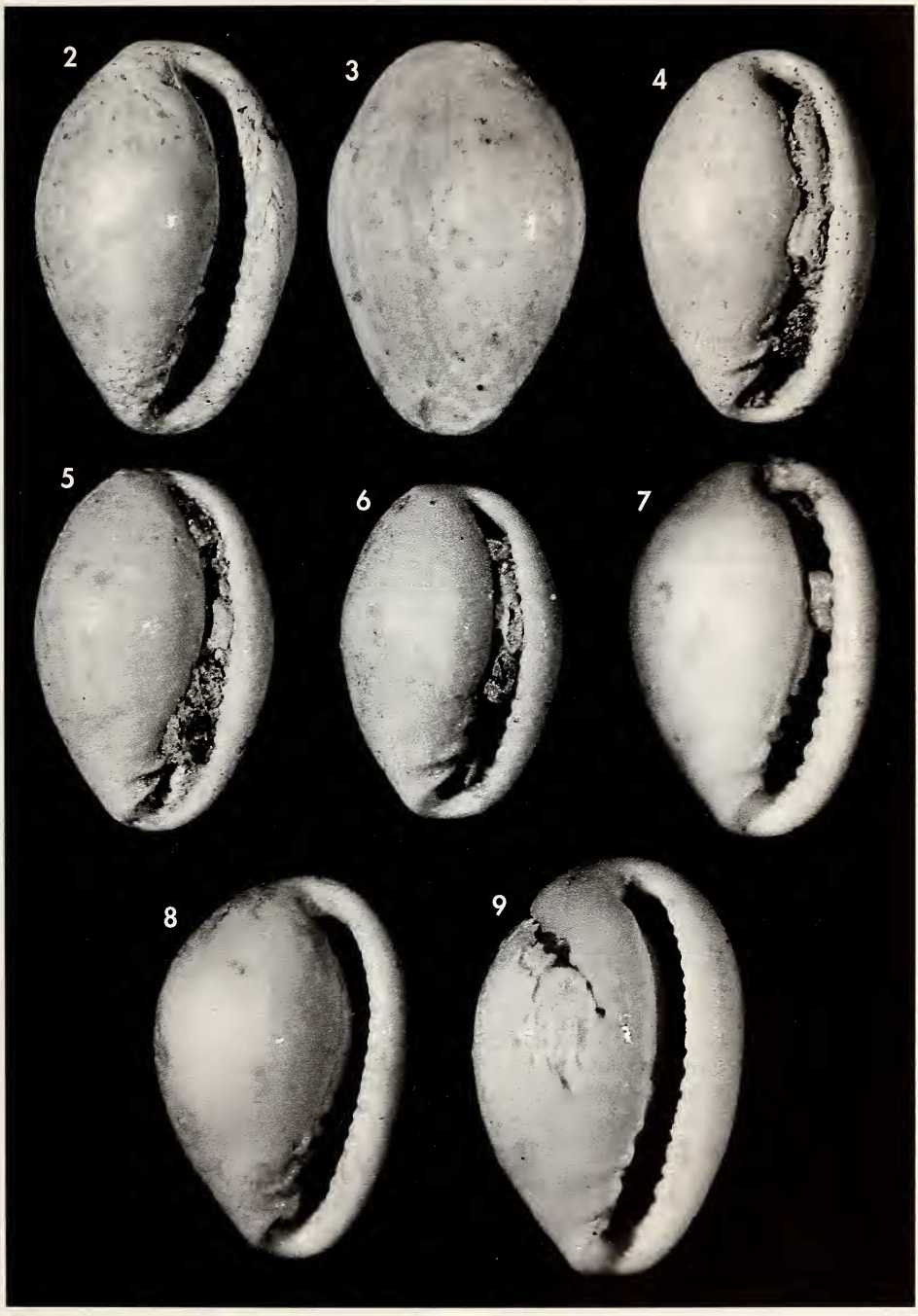
A Recent shelf species, *G. nofronii*, recently described by SMRIGLIO, GUBBIOLI AND MARIOTTINI (2001) from Northwest Africa (Western Sahara and Mauritania) shares similarities with the two Pliocene species. Its elliptic shape is particularly similar to that of *G. choffati* n.sp., including a certain broadening of the lip in its median part. Also plications shape and callus ridge strength are particularly similar to those of *G. choffati* n.sp., while the coarse lip denticulation resembles that of *G. elliptica*. *G. nofronii* differs from both species by being a little larger, slightly more slender and rostrated, and with a better defined siphonal slope-break.

DISCUSSION

Although most species of *Granulina* differ from one other only by subtle conchological differences, a number of shell features have been recently considered (GOFAS, 1992; LA PERNA, 1999; BOYER AND ROLÁN, 1999; LA PERNA *ET AL.*, 2002). As discussed by LA PERNA *ET AL.* (2002), morphological affinities may be of help to infer phyletic closeness within this genus, in spite of such a monotonous conchological pattern. An attempt of clustering some Pliocene, Pleistocene and Recent species was made by LA PERNA *ET AL.* (2002).

When *G. elliptica* was described, the impossibility to recognise any marked similarity with other fossil or living species was stressed, but the finding of *G. choffati* n.sp. now deprives *G. elliptica* of such a "uniqueness". These two species are so similar that a close phyletic relation between them is highly likely.

LA PERNA *ET AL.* (2002) recognised amongst the Mediterranean Pliocene shelf species of *Granulina* a mixture of warm and warm-temperate taxa, due to the occurrence of some extinct species with "African affinities", such as *G. clandestina* (a similar Recent species, *G. parilis* Gofas and Fernandes, 1988, is known from the Gulf of Guinea), together with a more temperate stock, well represented by *G. marginata* (Bivona, 1832) and *G. boucheti* Gofas, 1992, which are now the most common shallow-water species of the genus in the Mediterannean.



Figures 2-6. *Granulina choffati* n.sp. 2, 3: holotype, 2.1 mm; 4: paratype 1, 2.0 mm; 5: paratype 2, 2.0 mm; 6: paratype 3, 1.8 mm. Figures 7-9. *Granulina elliptica*. 7: holotype, 2.1 mm; 8: paratype, 2.1 mm; 9: paratype, 2.3 mm.

Figuras 2-6. Granulina choffati *n.sp. 2, 3: holotipo, 2.1 mm; 4: paratipo 1, 2.0 mm; 5: paratipo 2, 2.0 mm; 6: paratipo 3, 1.8 mm. Figuras 7-9.* Granulina elliptica. *7: holotipo, 2.1 mm; 8: paratipo, 2.1 mm; 9: paratipo, 2.3 mm.*

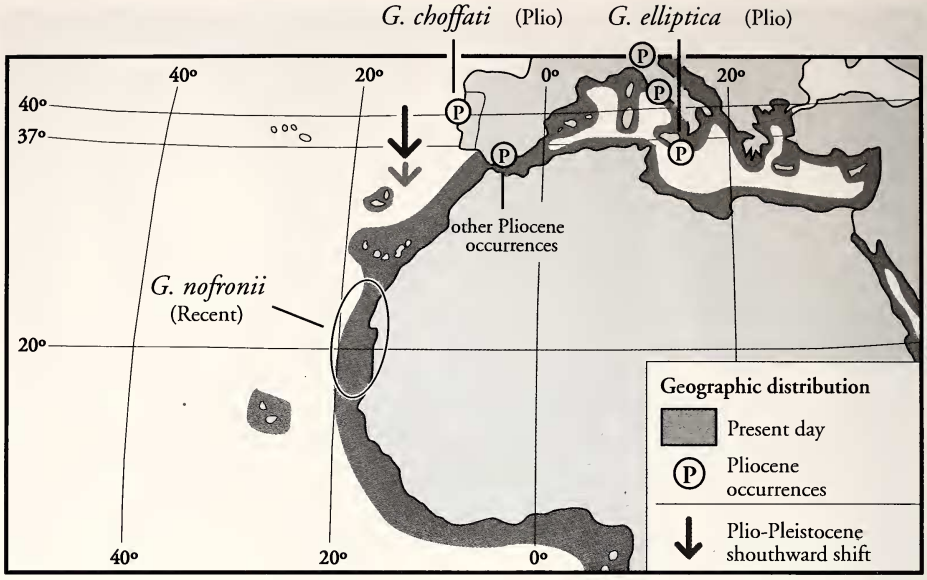


Figure 10. Present day Eastern Atlantic and Mediterranean distribution of *Granulina* and occurrences of *Granulina choffati* n.sp., *G. elliptica* La Perna, 2000, and *G. nofronii* Smriglio *et al.*, 2000. *Figura 10. Distribución actual en el Atlántico este y Mediterráneo de* Granulina *y citas de* Granulina choffati *n.sp.*, G. elliptica *La Perna, 2000, and* G. nofronii *Smriglio* et al., *2000.*

Also *G. elliptica* and *G. choffati* n.sp. may thus represent a group of species with a southern affinity, if the West African *G. nofronii* is regarded as a living representative of the same lineage. This does not imply a direct phyletic relation between these two species (*i.e.*, *G. elliptica* may be not the ancestor of *G. choffati* n.sp., or vice-versa). For the time being, the key point is to recognize groups of closely related species, sharing similar ecologic and biogeographic distribution. Changes in the distribution of these groups should be referred to major climatic changes, whose strong effects on distribution and diversity of Plio-Pleistocene benthic faunas are well known (*e.g.*, Di Geronimo, Di Geronimo, La Perna, Rosso and Sanfilippo, 2001; Monegatti and Raffi, 2001). Also the distribution and composition of *Granulina* and of marginellids in general, which typically have a warm-water distribution, must have been controlled by the Plio-Pleistocene cooling events. Actually, the diversity of *Granulina* in the shelf waters was higher in the Pliocene than in the present days (La Perna *et al.*, 2002 and unpubl. data; Chirli, 2002). Extinction of warm-water taxa, and/or local disappearance due to southward shifting, is the most important aspect of the Plio-Pleistocene history of shelf molluscs (*e.g.*, Stanley and Ruddiman, 1995; Monegatti and Raffi, 2001).

CONCLUSIONS

During the Pliocene, the genus *Granulina* ranged at least up to *ca.* 40°N (the latitude of Vale de Freixo) along the West Iberian coasts (Fig. 10). It should be admitted that such a Pliocene distribution represented but a step in the overall southward shift of *Granulina* in the Eastern Atlantic since its appearance (or its first documented occurrence) at higher latitudes in the Upper Oligocene (see introduction). Other Portuguese

Pliocene gastropod taxa show evidences of a similar southward migration (*e.g.*, among *Nassarius*, Gili, Silva and Martinell, 1995; *Solariella*, Silva, Landau and Martinell, 2000). From the Middle Pliocene (*ca.* 3.0 Ma) on, the southward shift of the Atlantic species of *Granulina* was, probably, more intense than previously, reflecting the sucessive Plio-Pleistocene sharp cooling pulses, the species with stronger termophilic affinities becoming rapidly extinct. The same pattern of extinction and/or local disappearance also occurred in the Mediterranean, where, simultaneously, some endemic taxa were appearing (La Perna *et al.*, 2002).

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